Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.

Supporting information:

Safe Near Infrared Light for Fast Polymers Surface Sterilization using Organic Heaters

Valentin Launay[1,2], Frédéric Dumur[3], Laurent Pieuchot[1,2], Jacques Lalevée*[1,2]

[1]Université de Haute-Alsace, CNRS, IS2M UMR 7361, F-68100 Mulhouse, France

[2]Université de Strasbourg, France

[3]Aix Marseille Univ, CNRS, ICR UMR 7273, F-13397 Marseille, France

e-mail: jacques.lalevee@uha.fr

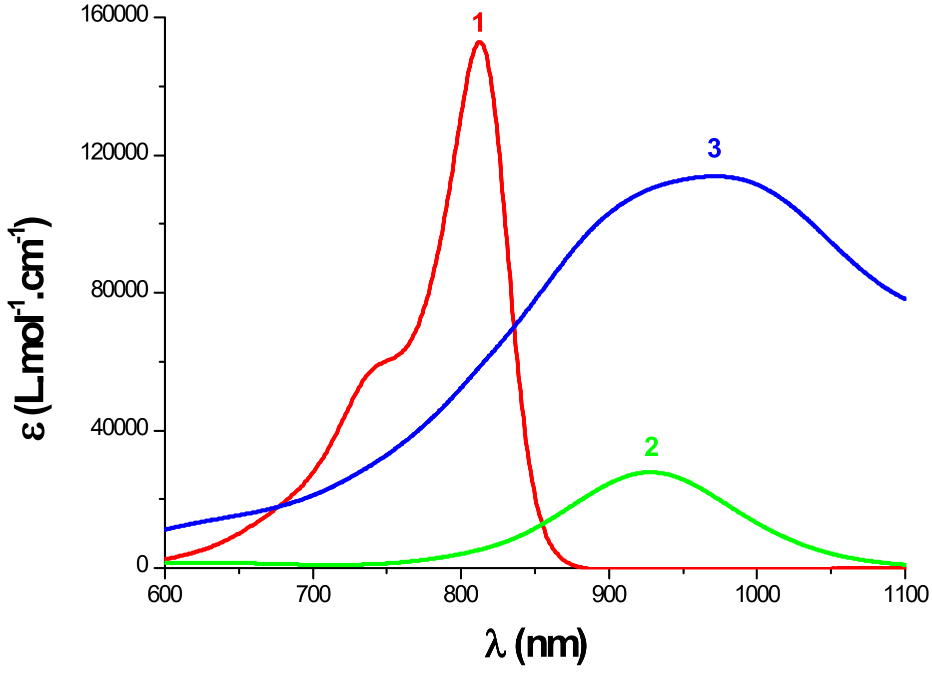

Figure S1. Molar extinction coefficients of (1) IR-813, (2) IR-940 and (3) IR-1064 in acetonitrile.

Comparison of the energetic costs:

On top of that, if we consider the worst sterilization case (1 h at 170°C to achieve a complete dry heat/NIR sterilization and 20 min at 121°C to achieve a complete moist heat sterilization), the NIR sterilization process is much less energy consuming than heat sterilization processes. Indeed, if we take 3W as light intensity, 3 min to reach the maximal temperature and 1 h to achieve the sterilization, we have a consumption of 3 x 63 x 60 = 11 340 J (0.0031kWh). However, there is loss of power in a semiconductor laser divided between waste voltage, waste current and optical loss. The efficiency is about 60% at 25°C but we will consider here the efficiency to be 50% (Peters, M.; Rossin, V.; Everett, M.; Zucker, E. In *High-Power Diode Laser Technology and Applications*, Vol 5 (Ed: M. Zediker), Society of Photo-optical Instrumentation Engineers, Bellingham, USA 2007). Thus, the final consumption is 11 340 x 2 = 22 680 J (0.0062kWh) for a sterilization in the conditions presented above.

For dry heat sterilizations, the requirement is to preheat the oven 1h before sterilizing. Therefore, 2 hours at 170°C are needed. Classical oven consumption varies from 0.7 to 1 kWh. Thus, the final consumption is at least 0.7 x 2 x 3 600 000 = 5 040 000 J (1.4 kWh) for a sterilization in the conditions presented above.

Moist heat sterilization is one of the most energy-intensive sterilization process. Cycles are separated into 3 phases. The first one is a pretreatment where the air is removed from the sterilization chamber and the load to be sterilized is gradually heated by a succession of high vacuum and steam injection. The second step is the sterilization process and the final step is the drying of the sample by prolonged vacuuming. For sterilizations at 121°C, 30 min are required for the pretreatment and 1 h for the post-treatment. Therefore, this sterilization is the most energy consuming sterilization method over the NIR/dry heat ones, requiring about 72 000 000 J (20 kWh) of electricity for each load and 500 L of water (McGain, F.; Moore, G.; Black, J. Hospital steam sterilizer usage: could we switch off to save electricity and water ?. *J Health Serv Res Policy* **2016**, *21*, 166).

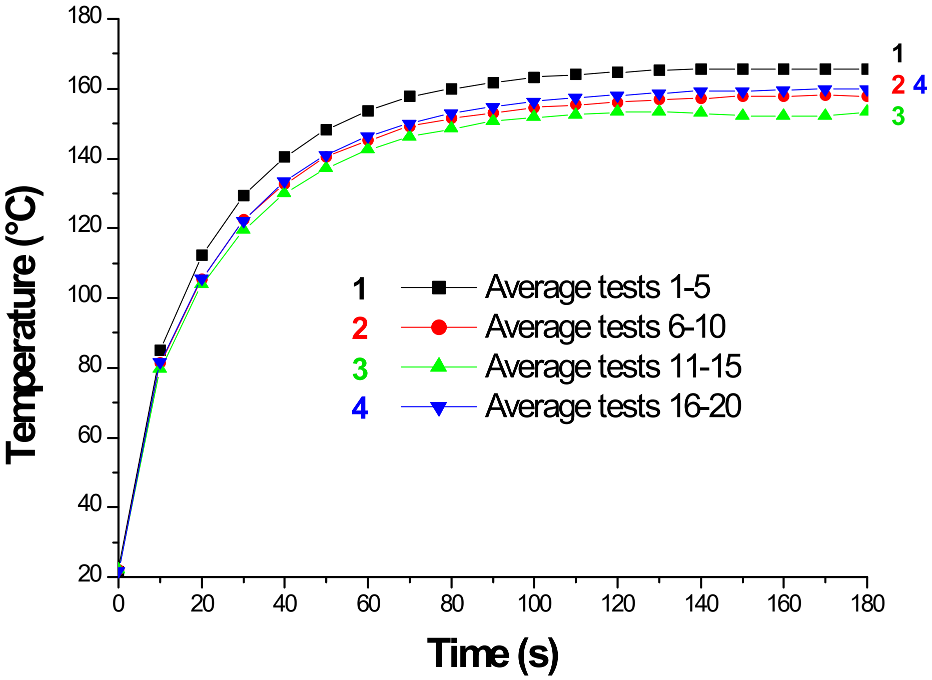

Figure S2. Temperature versus time of TMPTA-based polymer in presence of IR-813 (0.1%$_{wt}$) at 2.55 W.cm^{-2}. Irradiations are performed at 785 nm from t = 0 s to t = 180 s and stopped from t = 180 s. The recorded temperature profiles are the average profiles of successive irradiations.

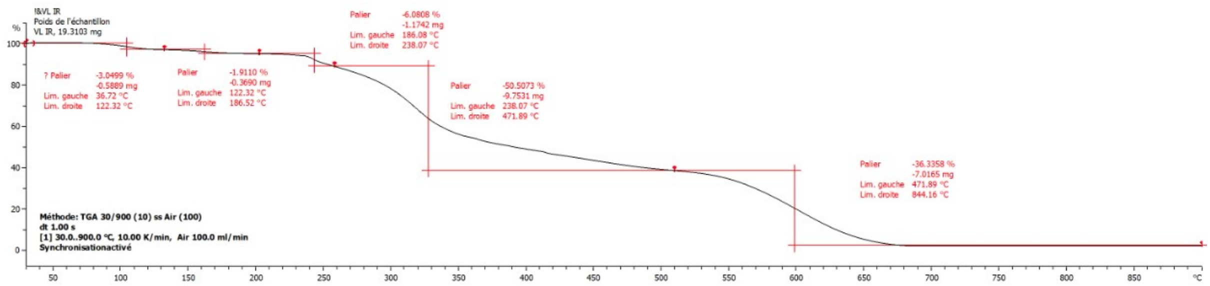

Figure S3. TGA graph under air of IR-813 from 30°C to 900°C with a rise in temperature of 10 K.min^{-1}.

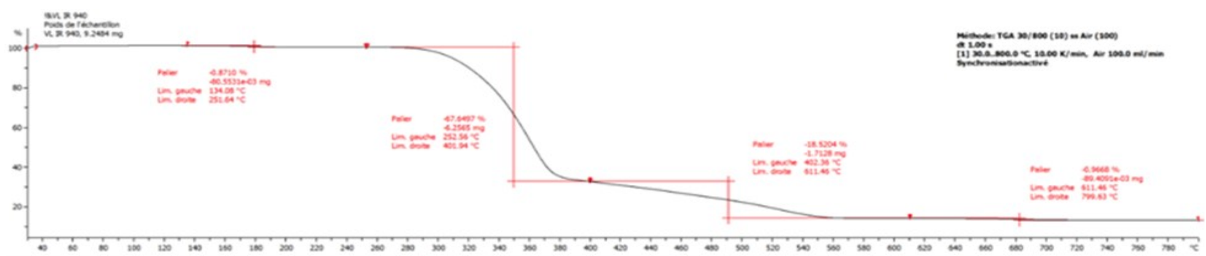

Figure S4. TGA graph under air of IR-940 from 30°C to 900°C with a rise in temperature of 10 K.min^{-1}.

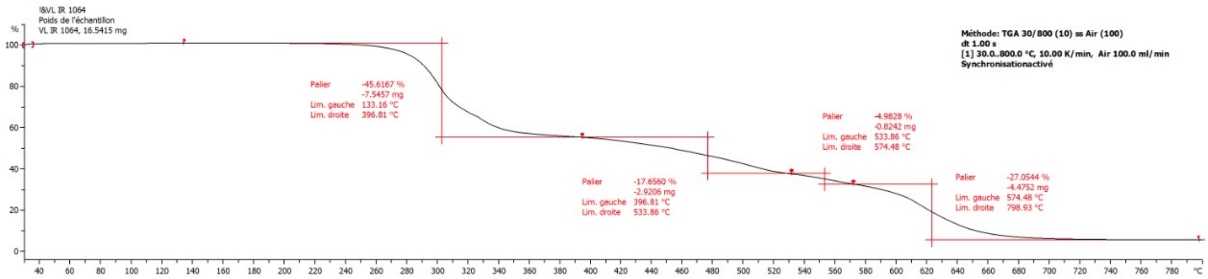

Figure S5. TGA graph under air of IR-1064 from 30°C to 900°C with a rise in temperature of 10 K.min^{-1}.

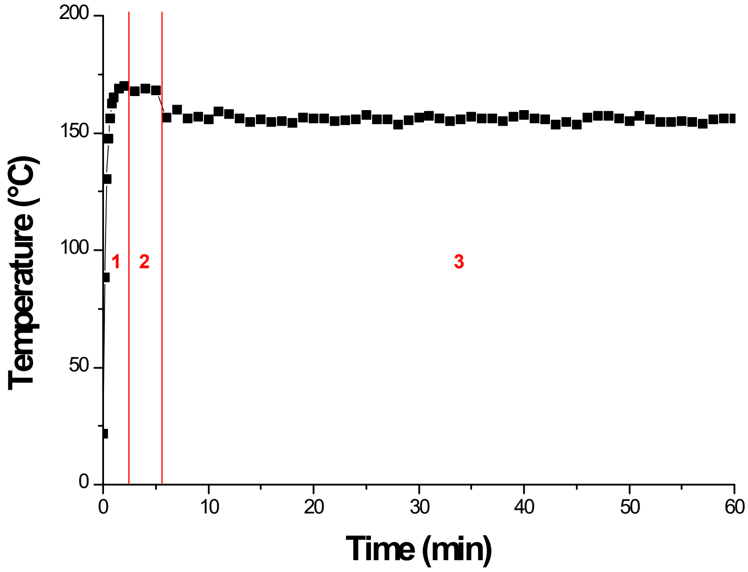

Figure S6. Temperature versus time of TMPTA-based polymer in presence of IR-813 (0.1%$_{wt}$) at 2.55W.cm^{-2}. Irradiations are performed at 785 nm from *t* = 0 min to *t* = 60 min and stopped from *t* = 60 min.

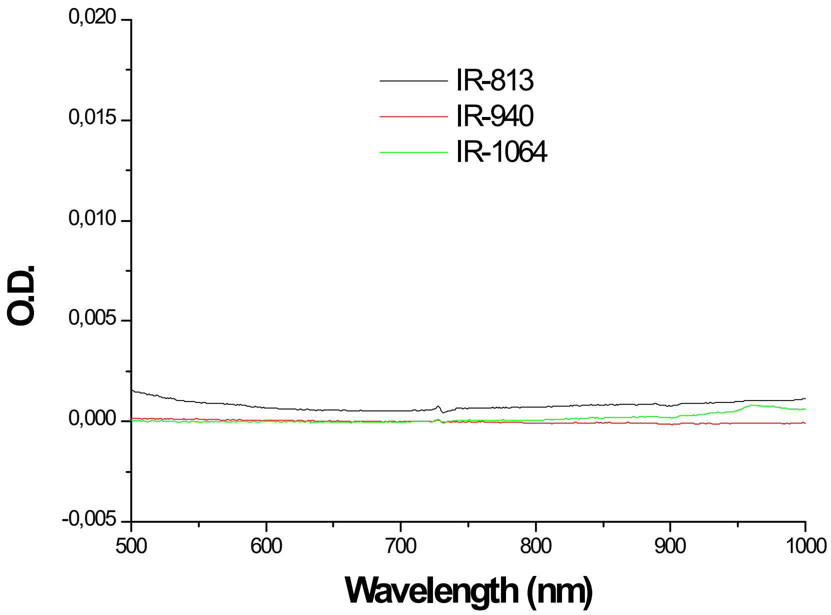

Figure S7. Absorption spectra of acetonitrile after immersing a TMPTA-based polymer sample containing NIR heater 1 day.

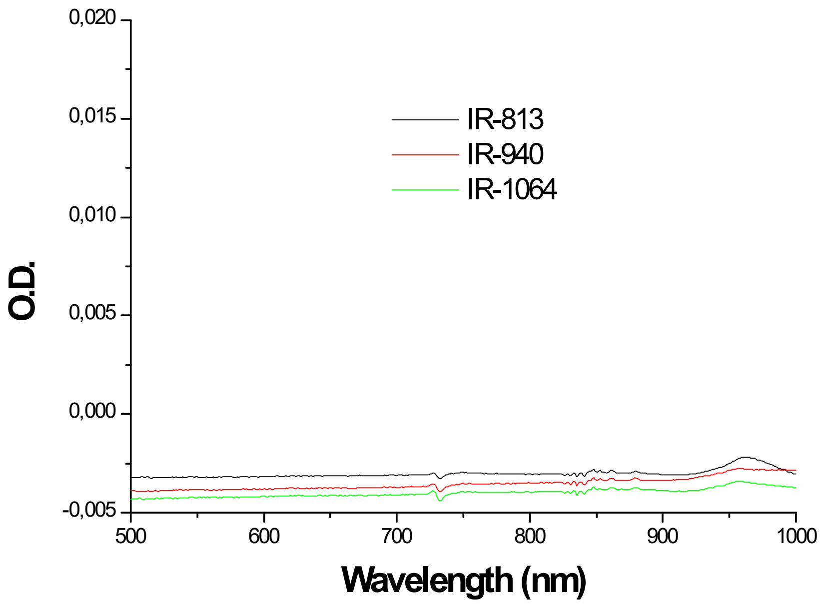

Figure S8. Absorption spectra of distilled water after immersing a TMPTA-based polymer sample containing NIR heater 1 day.